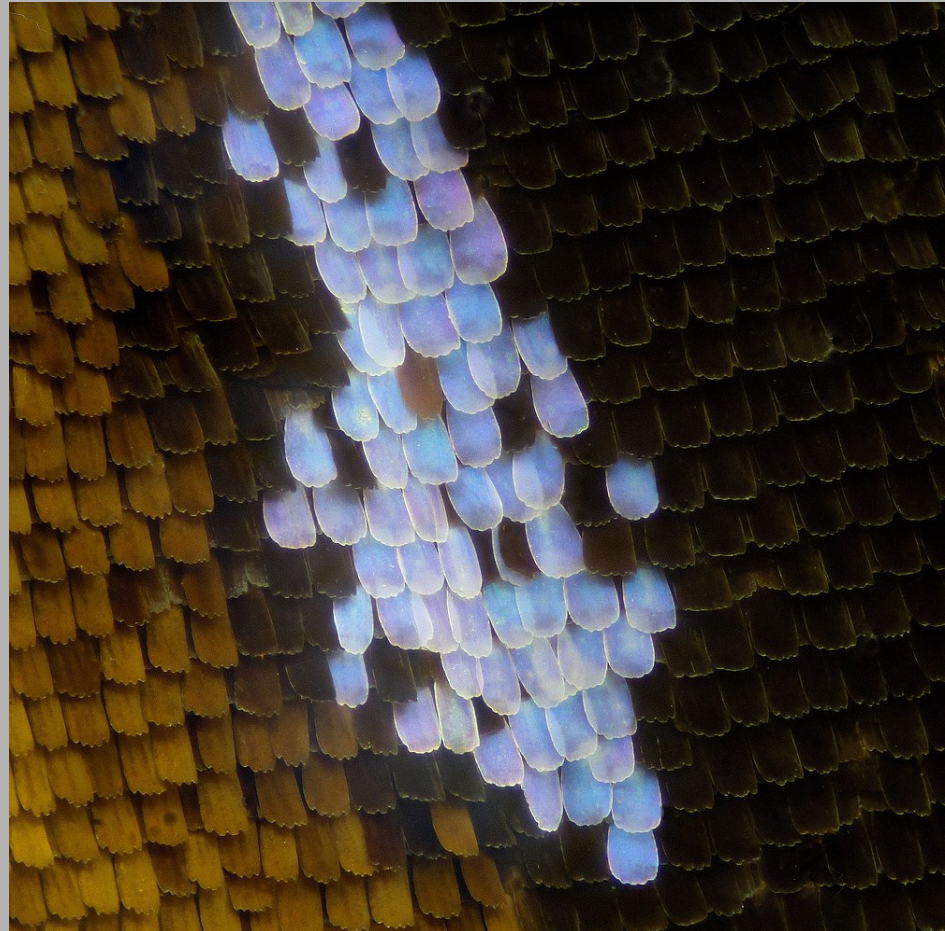


Lepidoptera

- Lepis = scale
- Scales = flattened setae
- Highest developed coloration



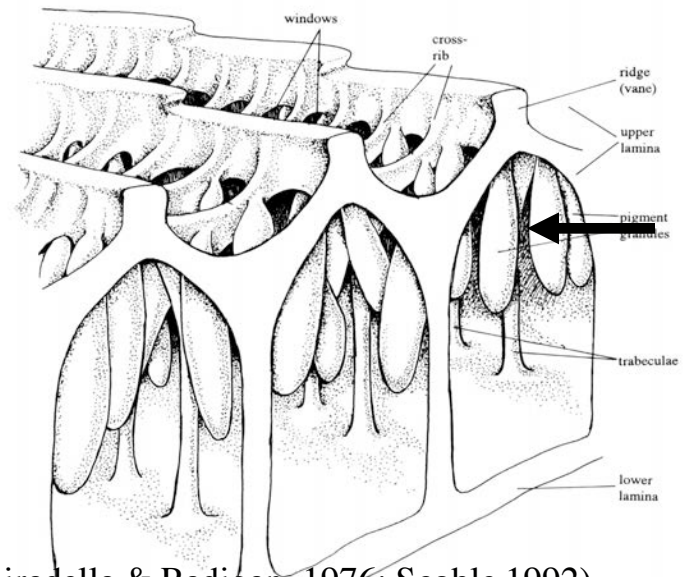
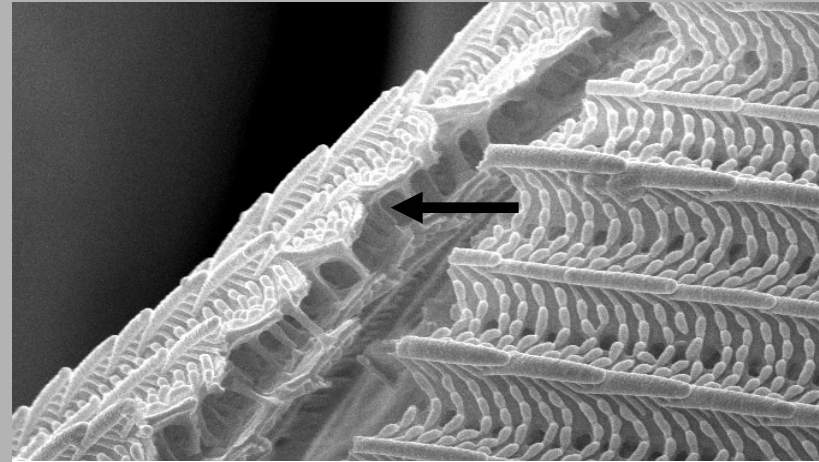
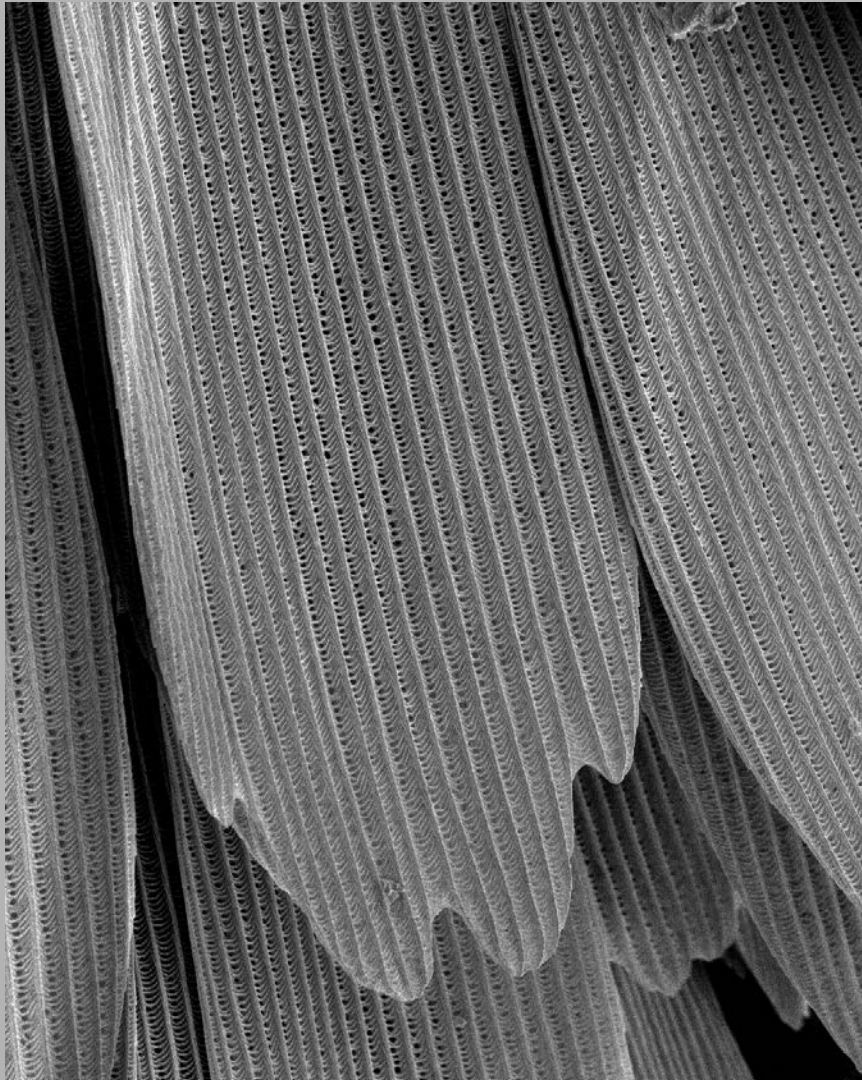
Diversity of Lepidoptera

	U.S. & Canada	World
Species	13,100+	160,000+
Families	84	133



Lepidoptera Scales

Flattened, hollow setae containing pigment



Ghiradella & Radigan, 1976; Scoble 1992)

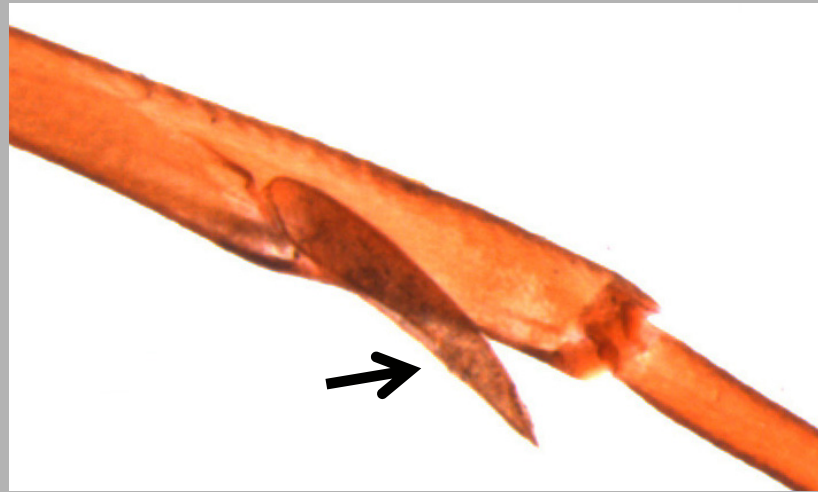
Lepidoptera

- Adult habits uniform.
- Primitively mandibulate
- Proboscis (maxillae) in most
- Liquid food
- Lachrymal feeders



Lepidoptera

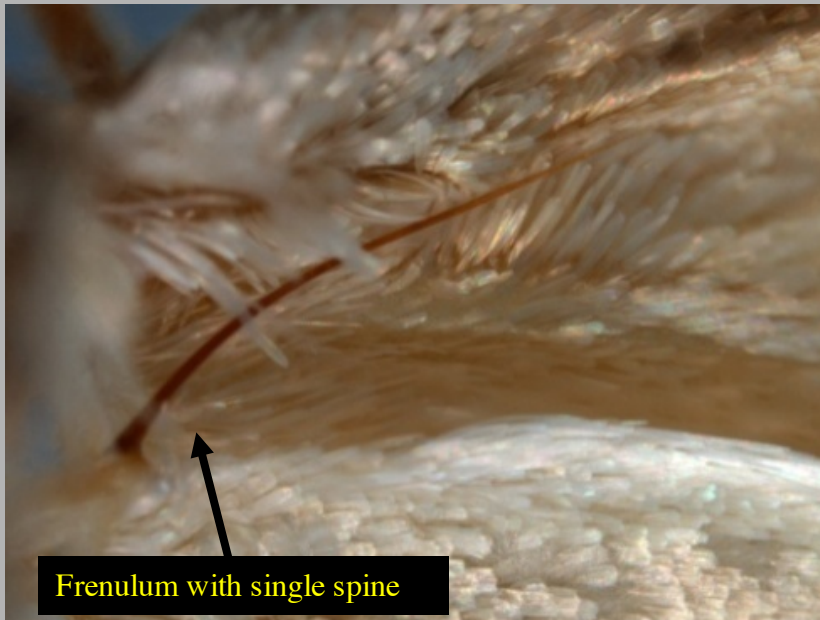
- Foretibial epiphysis



Chaetosemata



Hindwing Frenulum



Frenulum with single spine

male



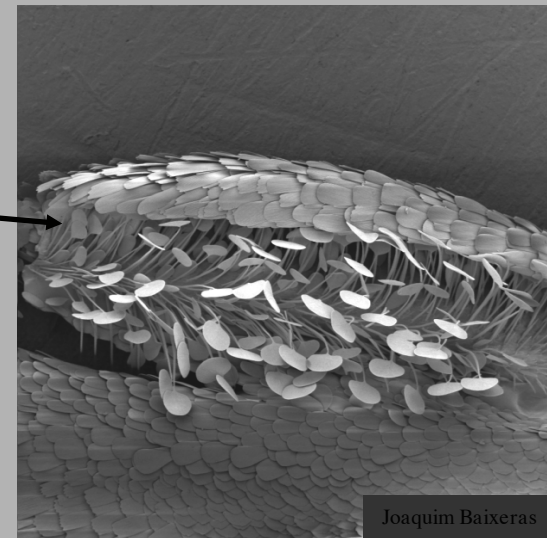
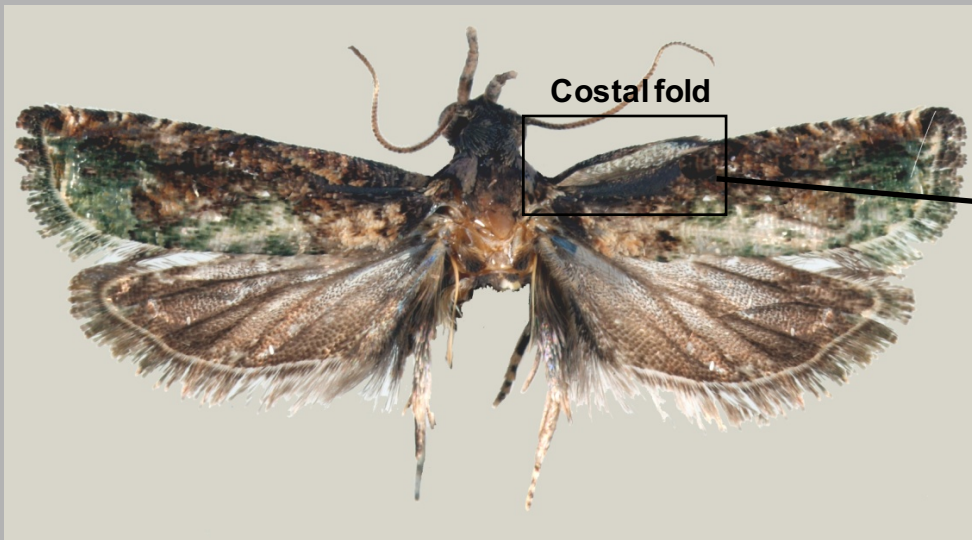
Frenulum with multiple spines

female

Pete Oboyski

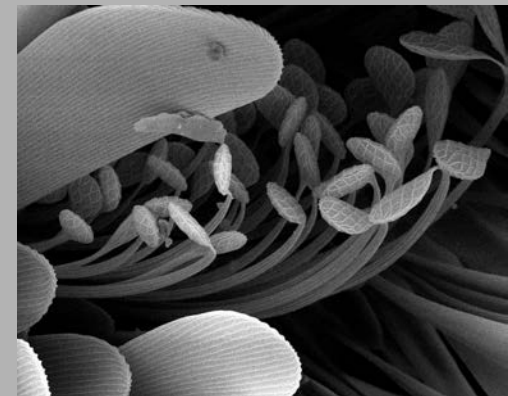
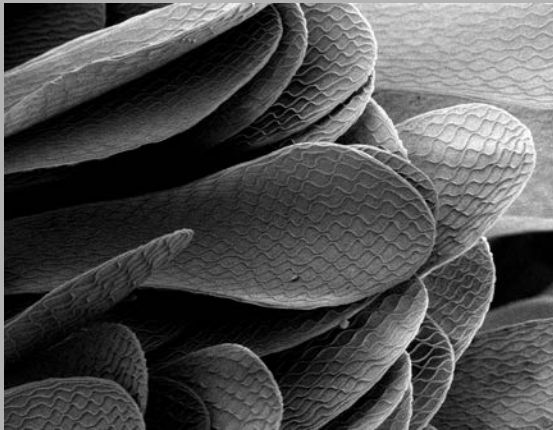
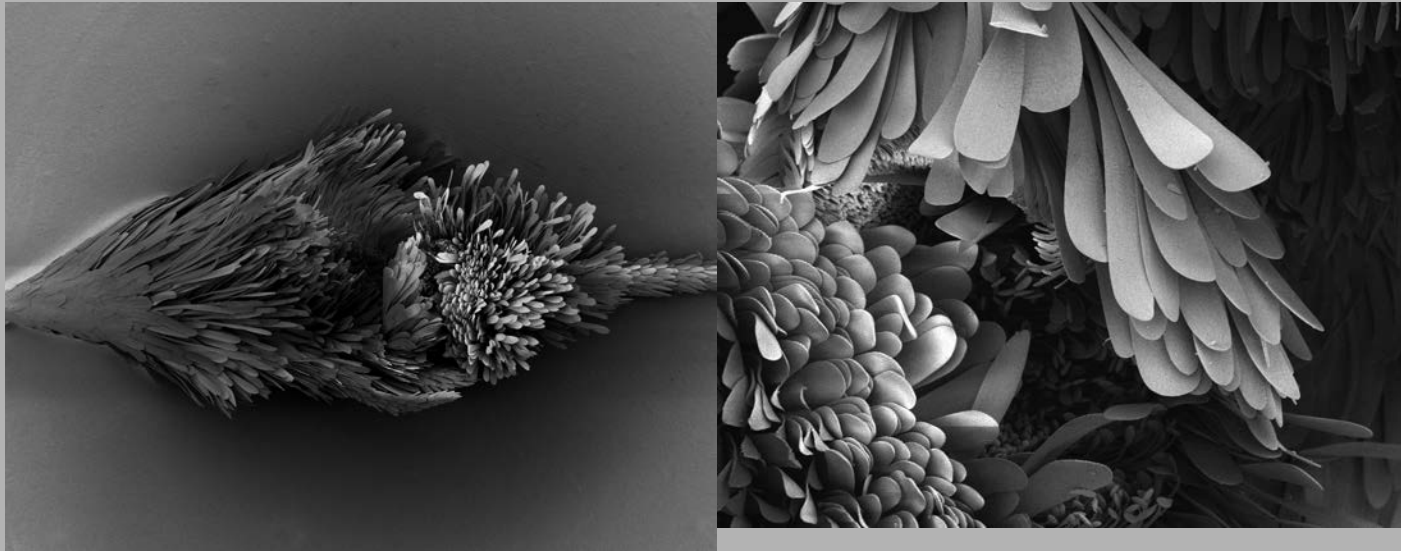
Male Sex Scales

Scales for producing and disseminating pheromones

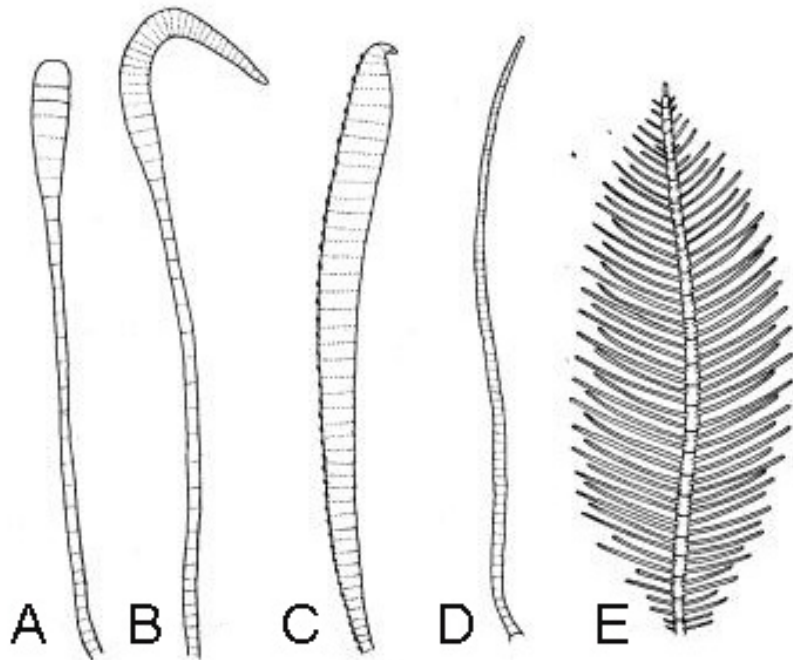


Hair pencils on abdomen and front legs

Hindleg of False Codling Moth (Tortricidae) -
an example of diversity of sex scales



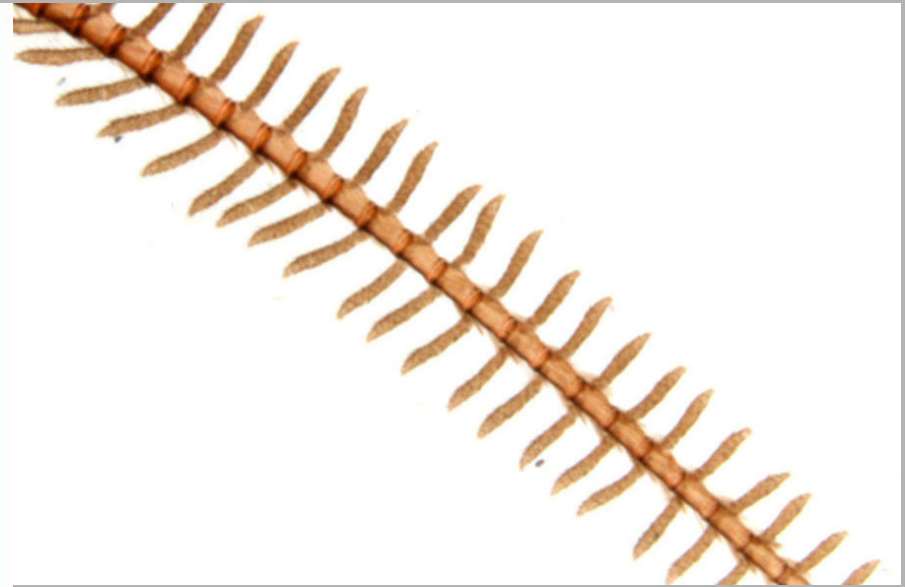
Antennae



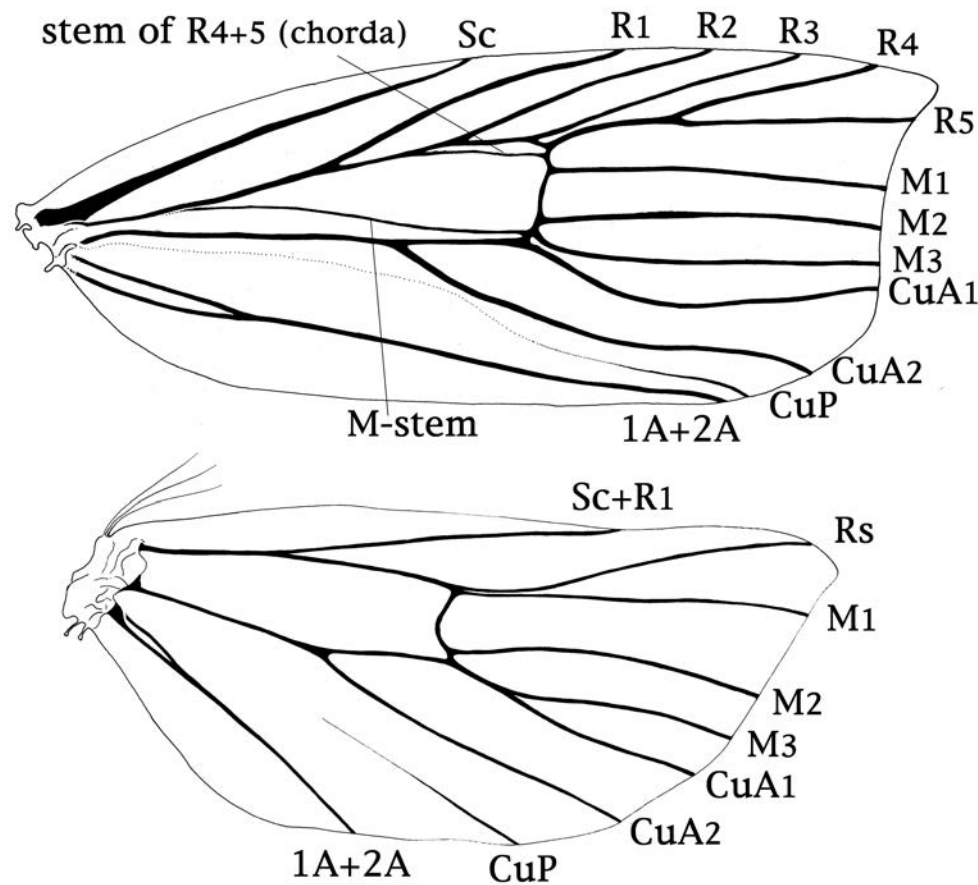
A: butterflies; B: skippers;
C, D, E: moths

A - Clubbed
B - Hooked
C - Widened

D - Simple
E - Pectinate



Wing Venation



Major Veins

Sc - Subcostal (1)

R - Radius (5)

M - Median (3)

CuA - Cubitus Anterior (2)

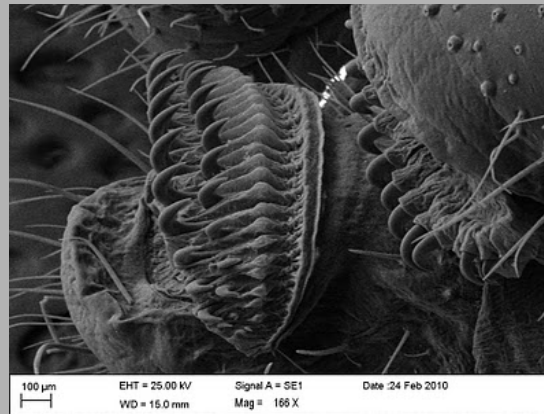
CuP - Cubitus Posterior (1)

A- Anal (2 or 3)

Larvae

Crochets on prolegs
(four abdominal, one anal),
Some with 1-2 pair lost

With or without secondary
setae





Many exposed larvae-
Aposematic or with other
defensive modifications



Diversity of Food Sources

Animal tissue and products

Fungi and lichens

Pollen and fern spores

Plant leaves, stems, roots,
seeds, fruit, flowers



Diversity of Feeding Habits of Caterpillars

Leaf mining

Stem, root, & fruit boring

Leaf-rolling

Exposed feeding



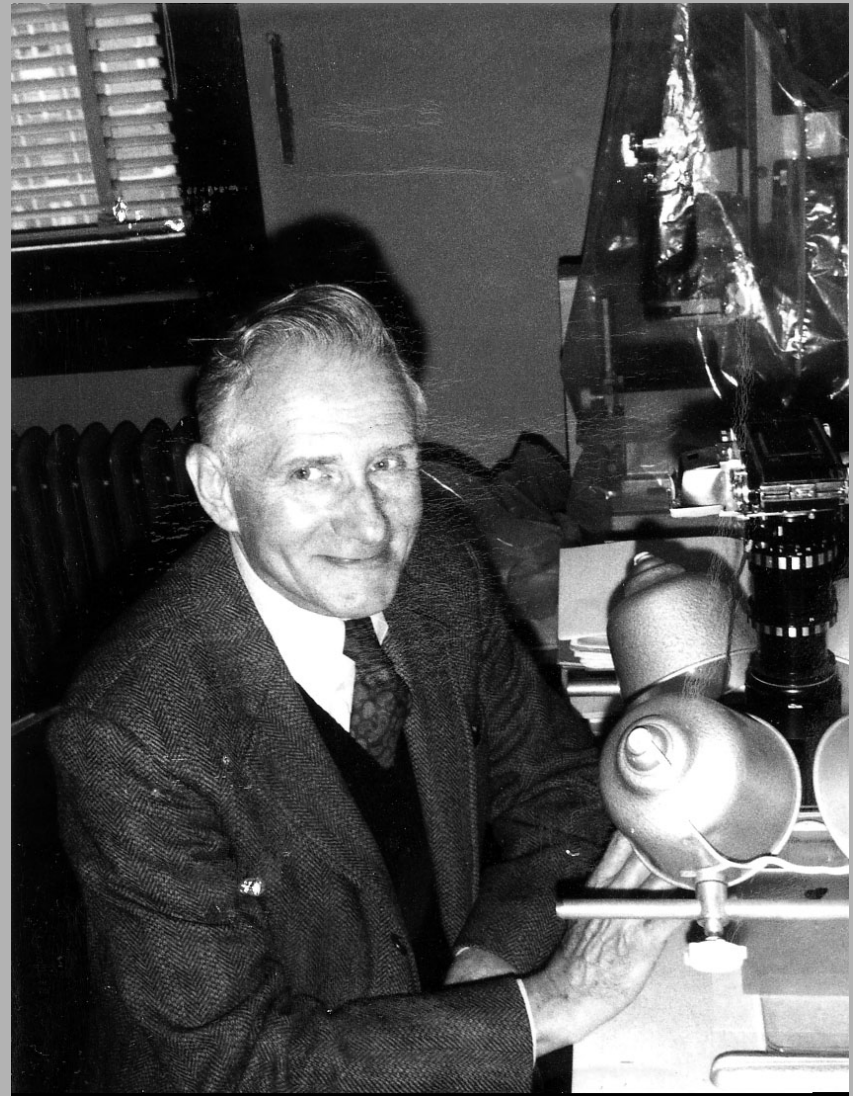
W.T.M. Forbes

- Lepidoptera of New York and Neighboring States



J.G. Franclemont

- Noctuidae
- Moths of North America series
- Many Lepidoptera students



Charles Covell

- Field Guide of Moths of Eastern U.S.



Dave Wagner

- Caterpillars of Eastern U.S.; Owlet Caterpillars



Previous divisions of Lepidoptera

- **Microlepidoptera**
 - small moths
 - fringed wings
 - 3 anal veins
- **Macrolepidoptera**
 - large butterflies and moth
 - 1 or 2 anal veins
- **Heterocera**
 - (various antennae)
 - moths
- **Rhopalocera**
 - (clubbed antenna)
 - butterflies

Phylogeny and Current Classification of Lepidoptera in North America

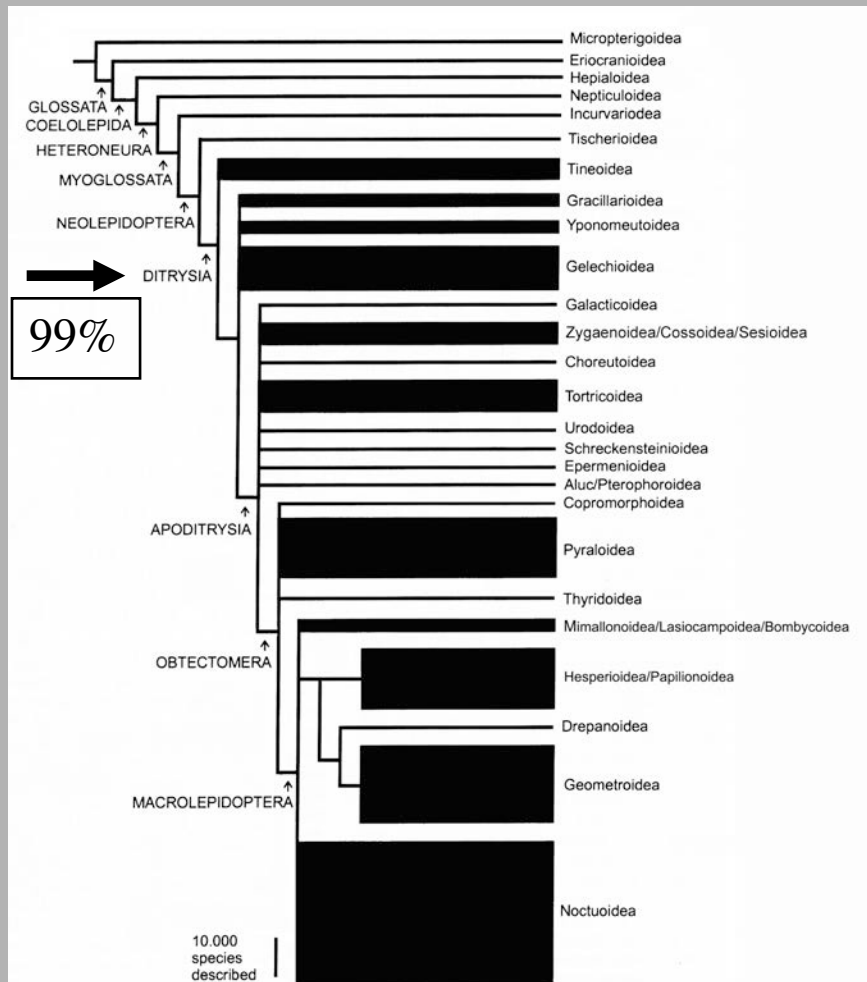
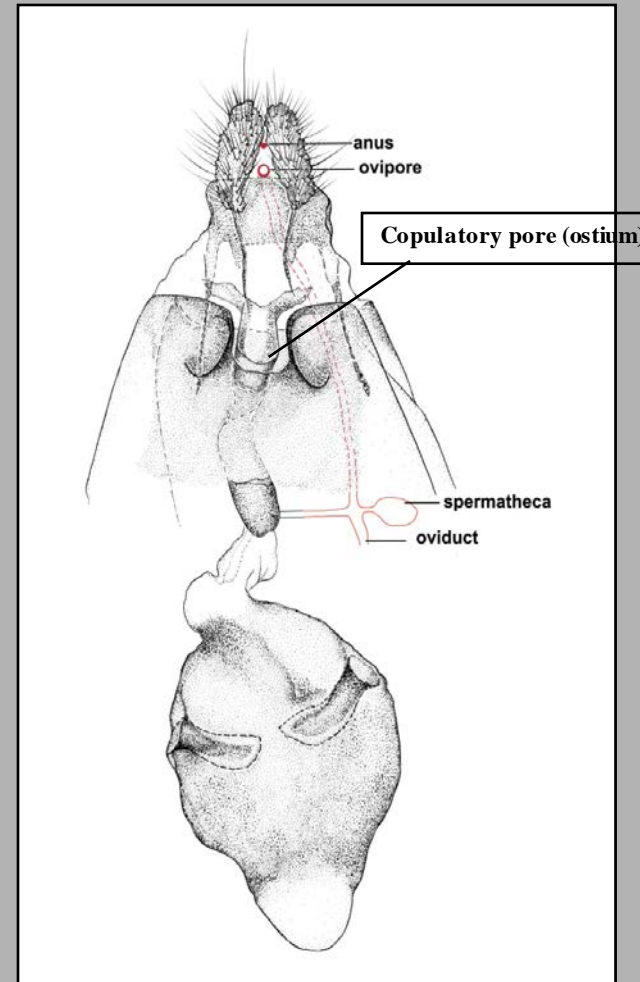


Fig. 1. Phylogenetic relationships of superfamilies of Lepidoptera present in the United States and Canada. Width of lines based on number of species worldwide (see scale bar). Modified from Kristensen and Skalski (1998).



99% Ditrysia - female with two genital openings

Suborders based on Mouthparts

- **Zeugloptera – adult with mandibles**
- **Glossata – adult with proboscis (often reduced)**

Suborder Zeugloptera

Micropterygidae

- Adults with mandibles for feeding on spores/pollen
- Larvae on liverworts
- 3 spp in N.America
30+ spp in New Caledonia







Suborder Glossata - Fabricius

- Linnaeus used wings for orders
- Fabricius used mouthparts



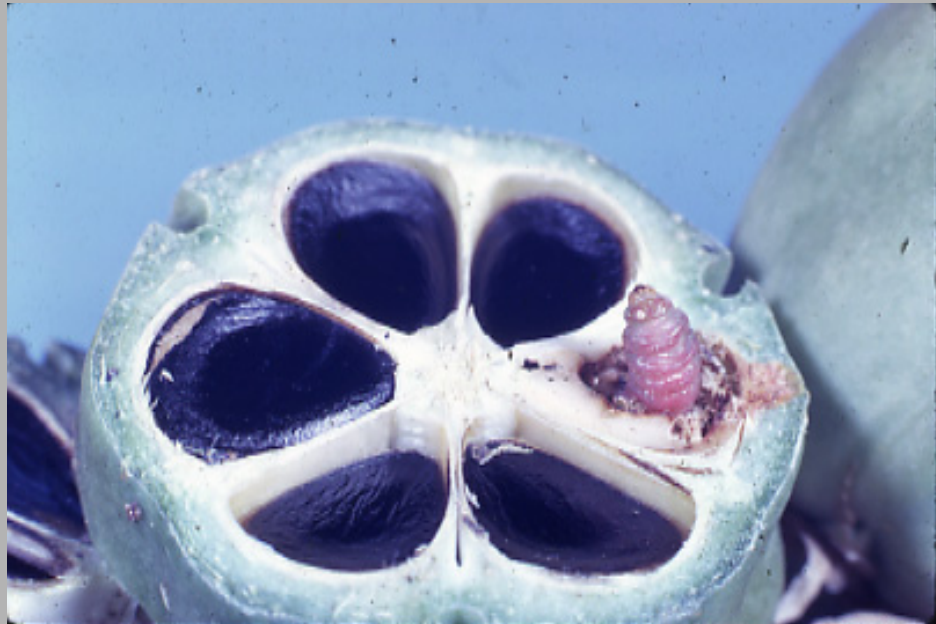
Prodoxidae – yucca moths

- Includes pollinators and “cheaters” of yucca
- Delayed development in some species.



Prodoxidae

- Female gathers pollen from one flower, spreads pollen and lays egg on second flower.
- Larva feeds on some of resulting seeds



Tineidae

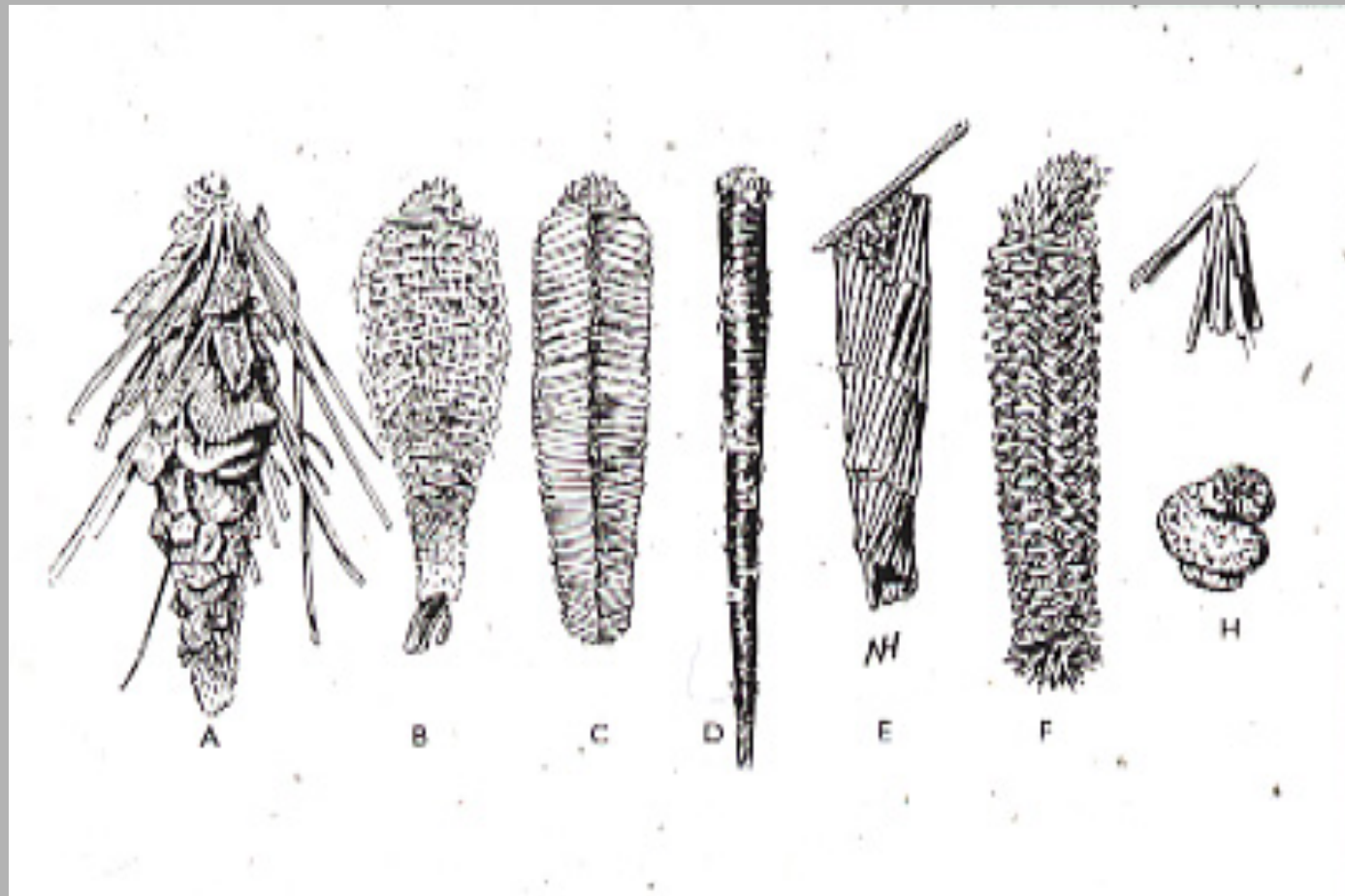
- Adult – bushy head
- Larvae scavengers or fungivores
- Clothes moths
- Some case makers



Psychidae - bagworms

- Males winged and females wingless, staying in bags
- Eggs overwinter in case
- Larvae case making, pupate in bags



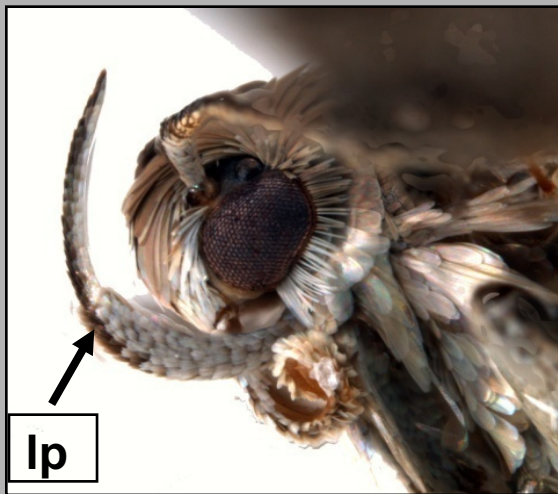


Cases of Trichoptera and Psychidae



Superfamily Gelechioidea

- Long, curved labial palpus



Gelechiidae

- Hindwings with prolonged apex
- *Pectinophora* - pink bollworm
- Some gall makers
- Sangmi Lee



Gelechiidae - *Sitotroga*
(Angoumois grain moth)



**Blastobasidae –
acorn moths
Dave Adamski**



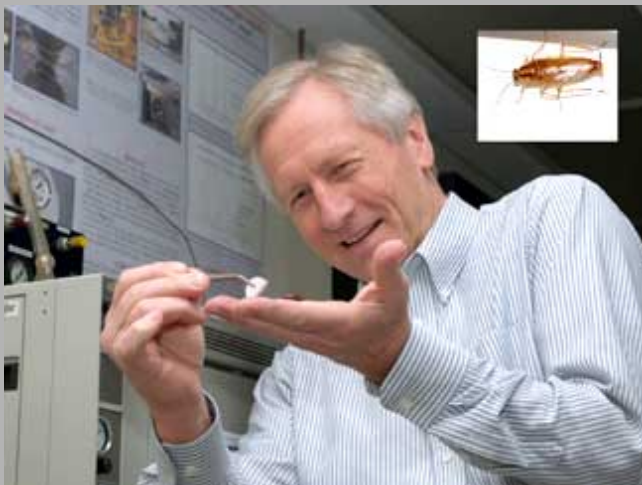
Coleophoridae

**includes many case
makers**



Tortricidae: Tortricinae

- Most species with basally arched wings
- Many leaf rollers
- Pheromone work by Wendell Roelofs



Tortricidae: Tortricinae

- *Choristoneura* - includes spruce budworm



Olethreutinae



Tortricidae: Olethreutinae

- Wings not arched at base; rolled around body
- Larvae leaf rollers/folders, fruit/seed feeders, stem/root borers, some gall makers
- Many forest pests, e.g., *Rhyacionia* (pine tip moths)



Tortricidae: Olethreutinae

- Many fruit pests, including oriental fruit moth, grape berry moth, and *Cydia* (codling moth and other spp).



Yponomeutoidea: ermine moths and others



©2007 Jeffrey Phippen



Lace cocoon of Urodidae

Cossidae - carpenter moths

- Larvae boring in stems/trunks of shrubs and trees



Sesiidae - clearwing borers

- Adults with clear wings
- Larvae internal borers in stems/roots, mostly trees and shrubs

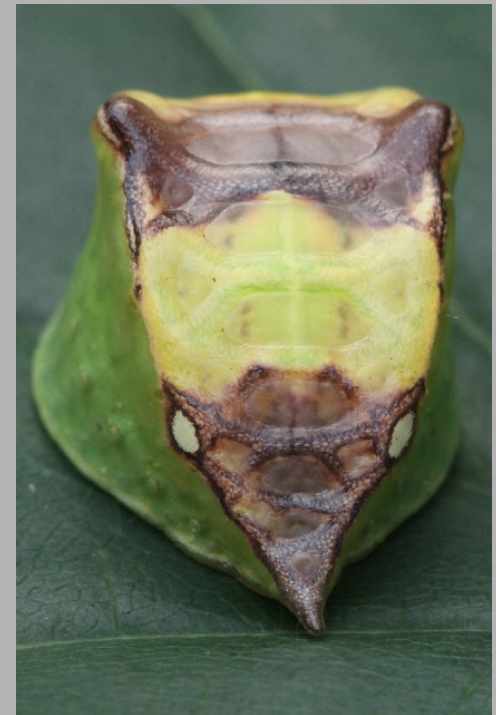


Limacodidae - slug caterpillars

- Brightly colored (aposematic) caterpillars with reduced prolegs and urticating setae



Limacodidae



Crambidae

- Formerly included in Pyralidae
- Tympanum on abdomen differs between two families
- Many spp with long labial palpi
- Includes sod webworms



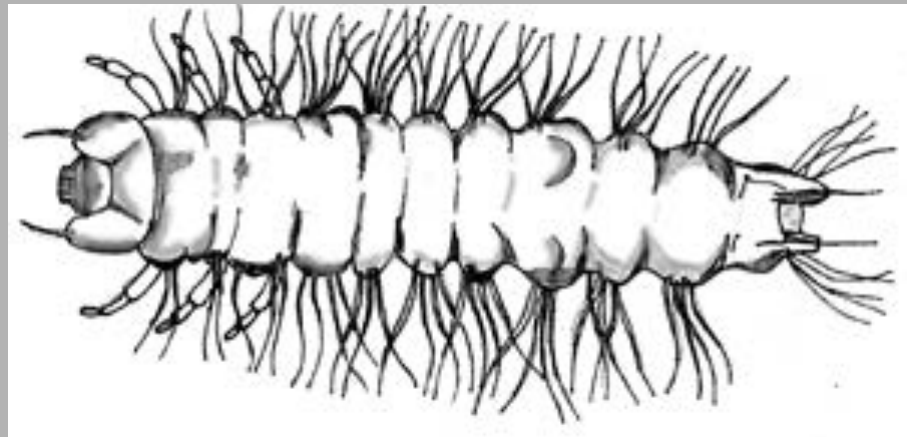
Crambidae

- Proboscis scaled
- Many spp with long labial palpi
- Includes sod webworms



Crambidae

- Some aquatic spp, larvae with tracheal or blood gills



Crambidae

- *Ostrinia* - European corn borer
- Southwestern corn borer



Crambidae - *Donacaula*

- Larvae in sedges and reeds
- Edda Martinez



Pyralidae

- Many leaf rolling larvae
- *Galleria* - wax moth, experimental species
- *Plodia* - Indian meal moth



© - josef hlasek
www.hlasek.com
Galleria melonella 2663

Cactus Moth in Australia

1925



1935



Pyralidae

- Cactus moth – [*Cactoblastis cactorum*]
- Invasive species in U.S.
- Egg sticks



Pterophoridae - plume moths

- Cleft wings
- Some internal borers





The Day Shift - to chrysalids and colors



What's the difference between a butterfly and a moth?

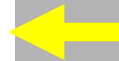
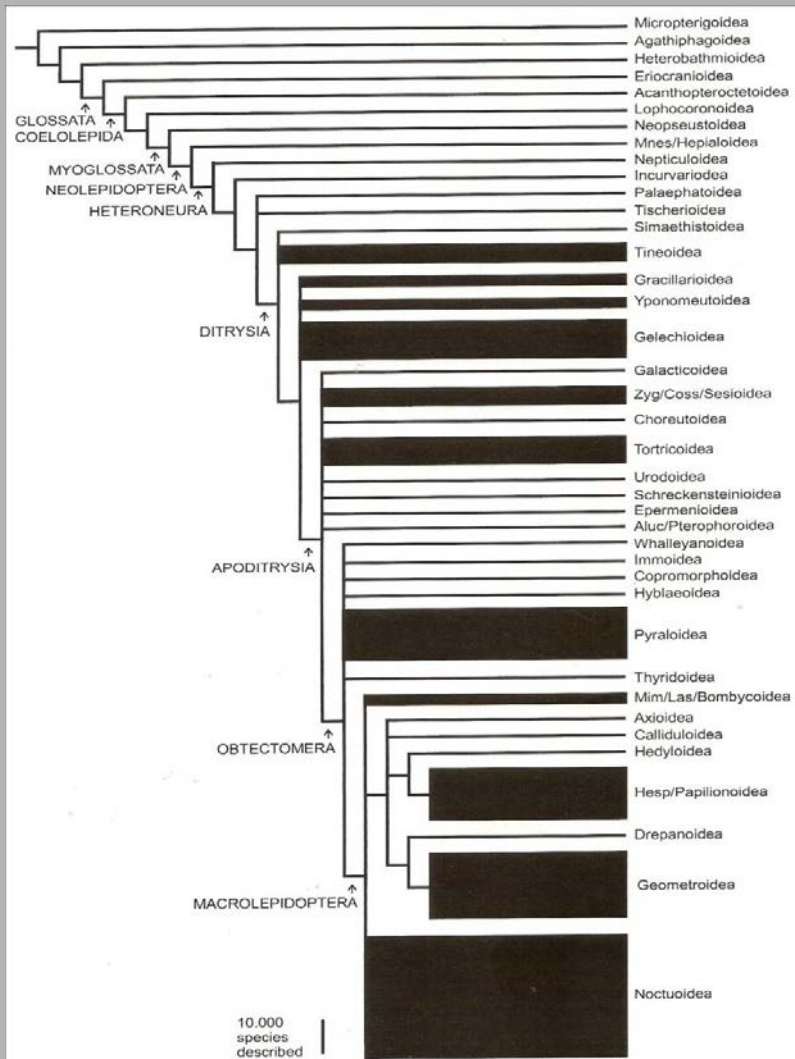


Fig. 2.2. Phylogeny of extant lepidopteran superfamilies. Width of superfamily lines indicate approximate numbers of described extant species (where these numbers are > 1000). Large sectors within the Ditrysia remain unresolved, and all proposed groupings above superfamily level in the Ditrysia must be considered very tentative.

Butterflies & Skippers (Rhopalocera)

- Lepidopterists Society
- Number of spp = birds



Butterflies & Skippers (Rhopalocera)

- Lepidopterists Society
- Number of spp = birds
- @ 17,500 species in world
- 750 species in N. America
- 147 species Mississippi



Hesperoidea - skippers

- Hooked antennae
- Wings separate and angled at rest
- Fly (skip) rapidly



Hesperiidae

- Larvae with large head and constricted neck
- Larvae on legumes & grasses/sedges
- Often with leaf shelters



Hesperiidae

Atalopedes Scudder

“feet of a princess”

Chateaubriand and *Atala*



Megathymidae

- Yucca skippers
- Larvae in stems/roots of yucca



Papilionoidea - butterflies

- Clubbed antennae
- Wide variety of herbaceous hosts, some trees/shrubs
- Many host specific at family/genus level
- Naked pupa - chrysalis



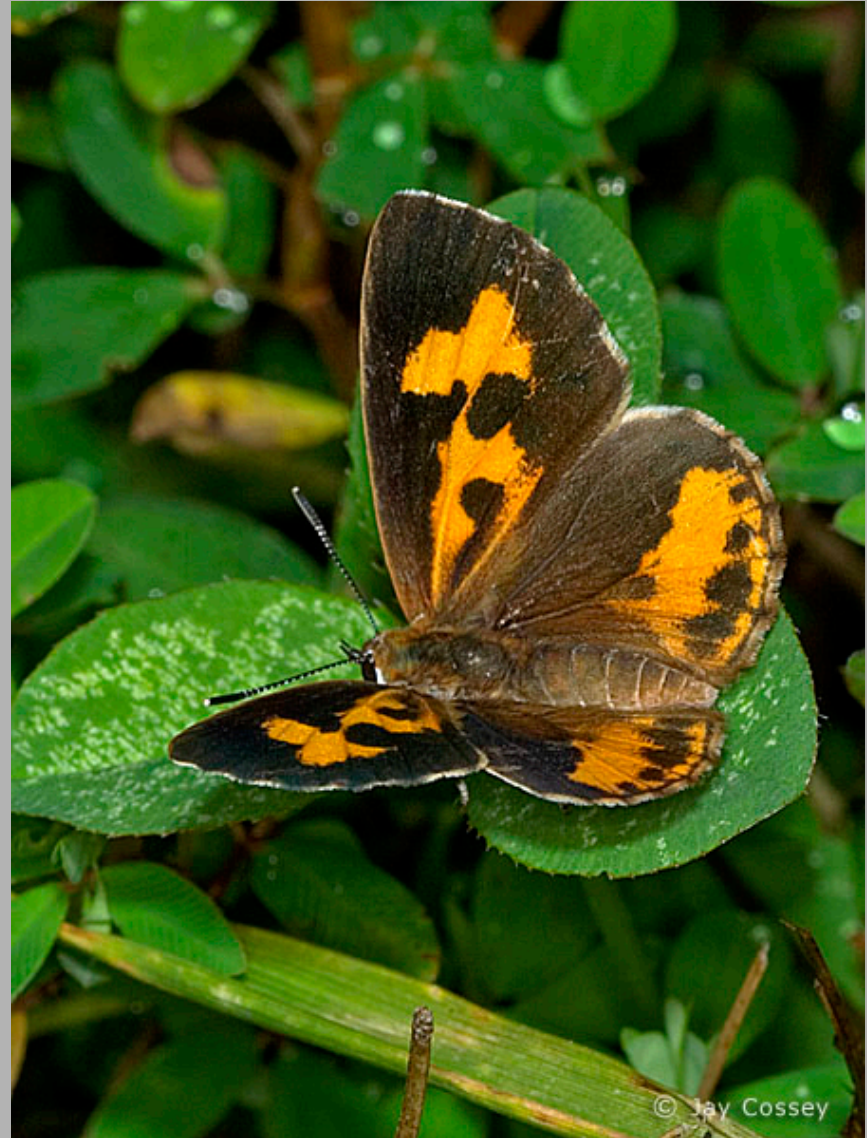
Lycaenidae - hairstreaks & blues

- Most spp with hair-like projections of hindwings and/or with blue color



Lycaenidae

- The Harvester
- Larvae predaceous on aphids



© Jay Cossey

Lycaenidae

- Larvae of some “blues” - ant tenders



<http://www.youtube.com/watch?v=GCo2uCLXvhk>

Lycaenidae

- Great blue hairstreak
- Larva on mistletoe



Pieridae - whites & sulphurs

whites

- Larvae on crucifers
- Imported cabbage butterfly
- Orange tip - Spring harbinger



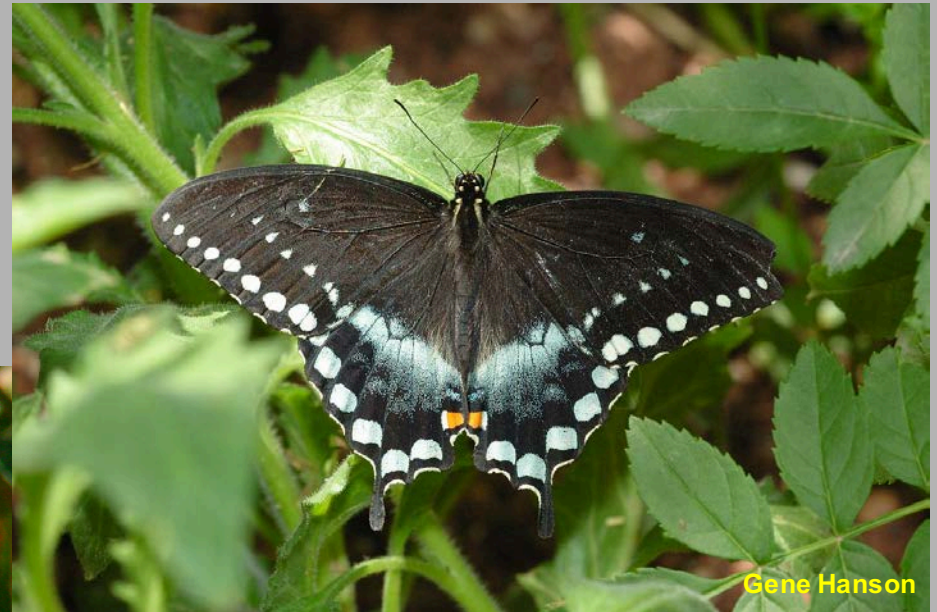
Pieridae - sulphurs

- Larvae on legumes
- Alfalfa butterfly



Papilionidae - swallowtails

- Eight species in MS
- State butterfly: spicebush swallowtail



Papilionidae - swallowtails

- Larvae of some spp with eversible osmeteria
- Pupae with silken belt

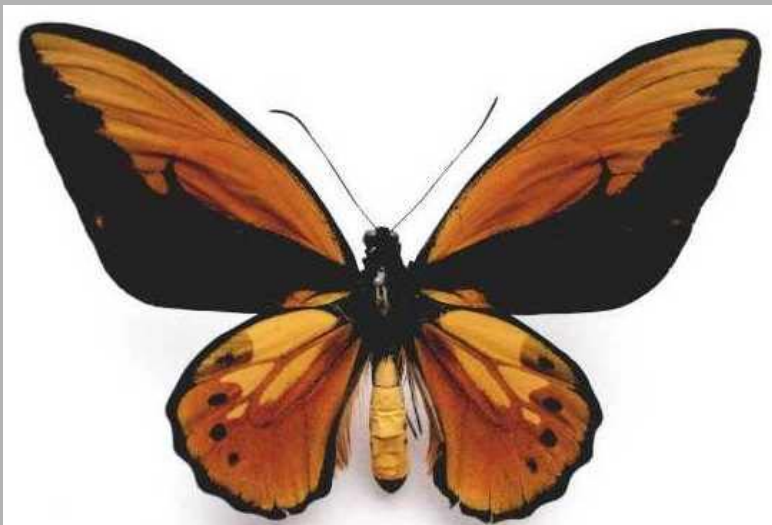
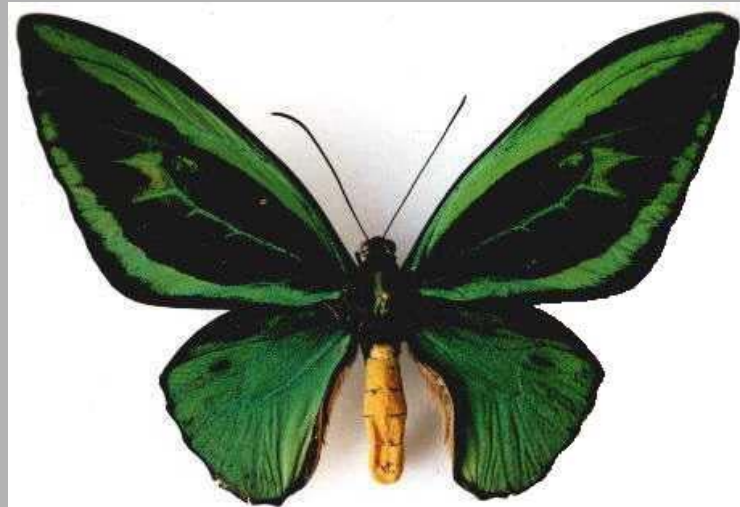
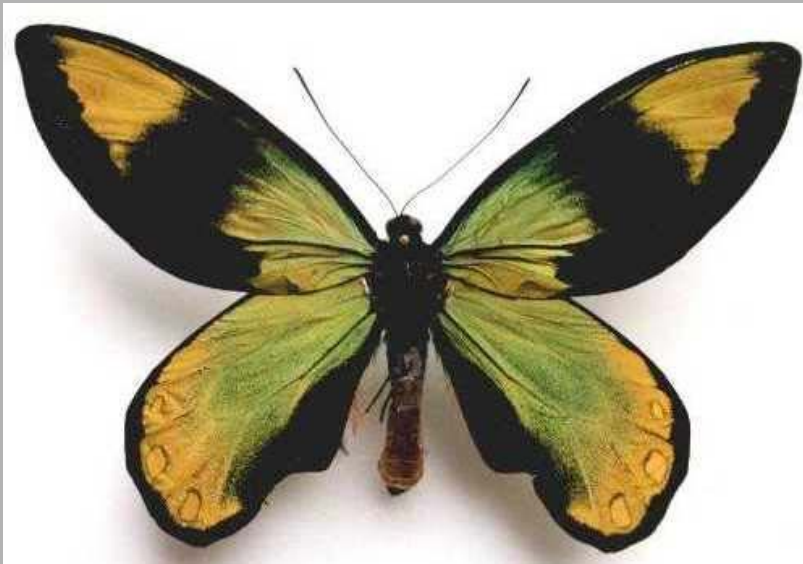


Papilionidae - swallowtails

- *Parnassius* - high altitudes



Papilionidae - birdwings



Nymphalidae - brush footed butterflies

- Adults with reduced forelegs



Nymphalidae: Nymphalinae



Nymphalidae: Nymphalinae



Nymphaline larvae



Nymphalidae: Danainae

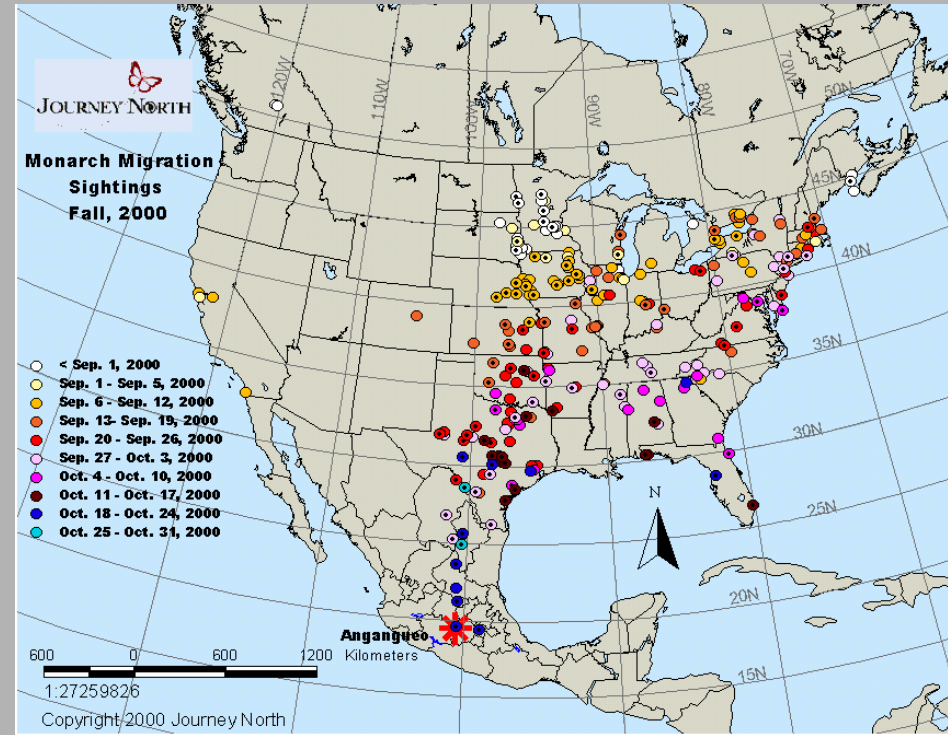
- Monarch, Queen
- Larvae on milkweeds, sequester chemicals for defense



Monarch migration



Catalina Trail - 1975 and 2013



Nymphalidae: Satyrinae - wood nymphs & satyrs

- Satyrs, wood nymphs
- Adults with eye-spots



Satyrinae

- Larvae on grasses, cryptic



What are the most common host families of butterflies and skippers in Mississippi?

- 147 species on 38 plant families (+ 5 polyphagous species)
- Asteraceae (composites) - 6 species
- Fagaceae (oaks) - 7 species
- Fabaceae (legumes) - 23 species
- Poaceae (grasses) - 40 species

Geometridae - measuring worms

- Adults delicate, slender body, etc
- Flight weak, hold wings flat at rest
- Tympanum on abdomen



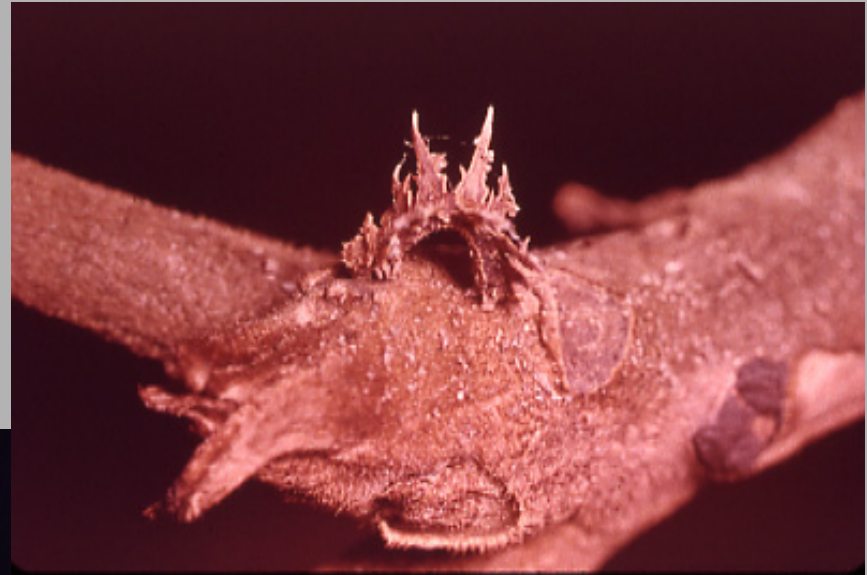
Geometridae - measuring worms

- Larvae - “measure” with looping; loss of 3 pairs prolegs



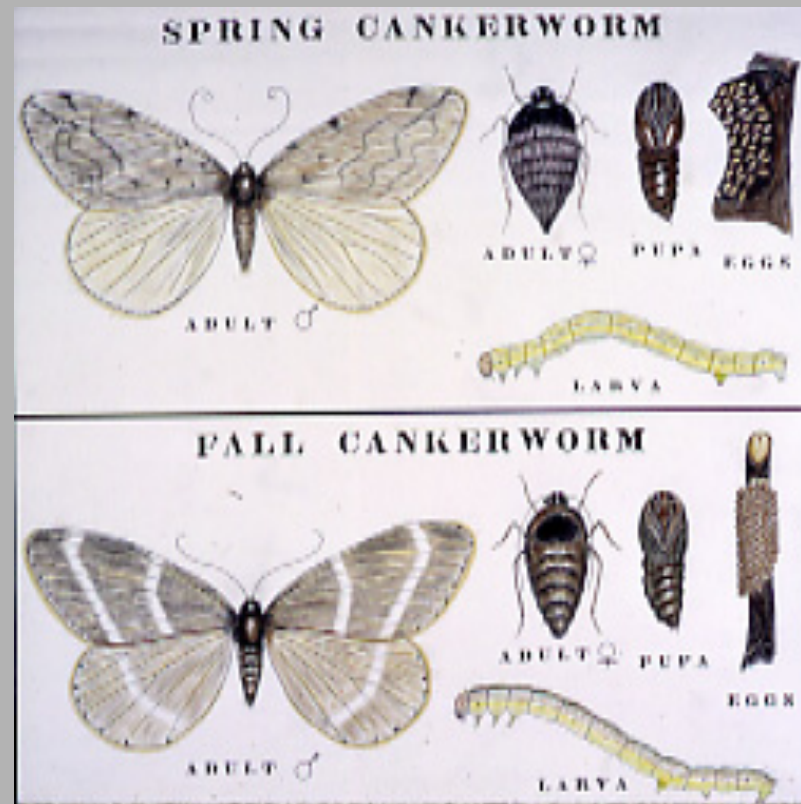
Geometridae - measuring worms

- Some spp cover body with bits of leaves/flowers



Geometridae - measuring worms

- Spring/fall cankerworms
- Males fly at 40° F
- Females wingless



Geometridae - measuring worms

- Industrial melanism -
Biston betulariae



Lasiocampidae - tent caterpillars

- Hinding humeral area expanded
- *Malacosoma* - tents in late spring on plum, cherry, etc. in crotch

Eggs in mass

Larvae leave tent to feed.



Lasiocampidae

- Tent caterpillar larva



- Forest “tent” caterpillar
- No tent



Bombycidae - silk moth

- *Bombyx mori*
- Only domesticated species of insect
- Feed on mulberry



Bombycidae - sericulture

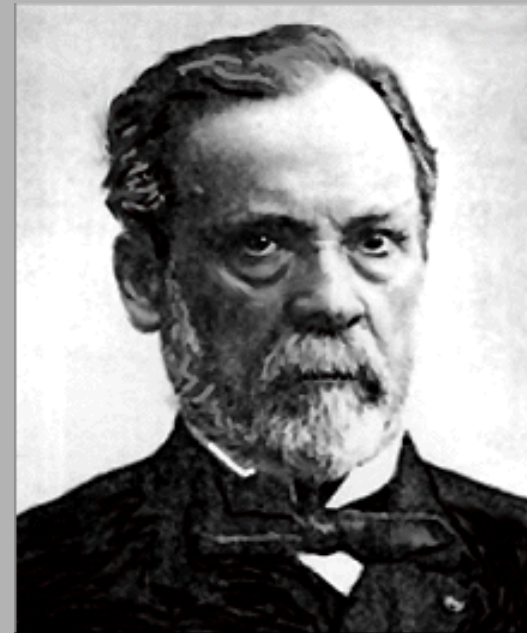
- Single thread from one cocoon about 1/2 mi long
- 3,000 cocoons for 1 lb silk



Bombycidae - entomological history

- Bassi - muscardine disease
- *Beuveria bassiana*

Pasteur



Saturniidae

- Proboscis reduced
- Adults short lived
- Some with thick cocoons



Saturniidae - Citheroniinae: Royal & Imperial Moths

- Hickory horned devil
- Pupate in soil; no cocoon



Regal Moth, *Citheronia regalis* (female) [J. H. Campbell - All Rights Reserved]

© Stephen Creswell



Saturniidae - [Hemileucinae]

- Io moths & buck moths
- Larvae urticating



Saturniidae - Saturniinae

- Luna, Polyphemus, Cecropia, Prometheus
- Strong cocoon, double or single wall



Sphingidae - sphinx moths

- Long proboscis
- Many crepuscular



Sphingidae

- Larvae – hornworm



Sphingidae

- *Manduca* -
tomato/tobacco
hornworms
- Pupa with proboscis
separated



The problem with Noctuoidea

- Formerly Notodontidae
Lymantriidae, Arctiidae,
and Noctuidae
- Now Notodontidae,
Erebidae, Noctuidae,
and two smaller
families.
- Erebidae now includes
Lymantriinae, Arctiinae,
and some other
subfamilies.
- All with tympanum on
thorax

Notodontidae - prominents

- Many with lobe on hind margin of FW; some roll wings around body



Notodontidae

- Larvae on trees/shrubs, often gregarious
- Anal end often held above body



Notodontidae



Erebidae: Lymantriinae - tussock moths

- Wide wings, velvety appearance
- Larvae usually hairy with tufts on back
- Mostly on trees/shrubs;



Lymantriinae - *Lymantria*

- Gypsy moth
- Flightless females
- Eggs in masses
- Dispersal by ballooning, RV's



Erebidae: Arctiinae - woolly bears, tiger moths

- Adults often with spots on abdomen and hindwing
- Much variation in wing color/pattern within some species





Arctiinae - reflexive bleeding



Arctiinae - *Hyphantria* (Fall webworm)

- Webs in terminals, summer/fall, larvae always inside web
- Persimmon, walnut, ash + 100 other hosts



Arctiinae – [Ctenuchini]



Bill Connor Lab, Wake Forest, and Soundscape Ecology

<http://www.sciencefriday.com/video/07/17/2009/moths-can-escape-bats-by-jamming-sonar.html>

Erebidae: Catocalinae

Catocala - underwings



Noctuidae

- Largest family
- Reniform and orbicular spots
- Larvae usually smooth bodied, dull colored,



[Acronicta] dagger moth larvae



Spodoptera - armyworms

- Larvae may migrate in large numbers



Agrotis - subterranean cutworms

- Larvae cut stems at base during night
- Other cutworms may climb plants



Heliothis - budworm

Helicoverpa - bollworm, corn earworm

